CryoSat-2 for Inland Water Applications – Potential, Challenges and Future Prospects

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Abstract

Hydrologists are increasingly exploiting advances in remote sensing technologies. Numerous studies have used altimetry observations from the ESA mission CryoSat-2 to extract water surface elevations (WSE) for inland water bodies such as lakes and rivers despite the satellite being primarily designed for cryospheric studies. Until the launch of Sentinel-3, CryoSat-2 was the only radar altimetry mission to operate in the high resolution Synthetic Aperture Radar (SAR) mode, and it is still the only mission operating in Synthetic Aperture Interferometric mode (SARIn) over selected inland regions like the Amazon (SAR mode), the Brahmaputra, the Tibetan Plateau and parts of the Zambezi (SARIn mode). The long-repeat orbit sampling pattern of CryoSat-2 is particularly interesting but challenges traditional processing methods for radar altimetry over inland water bodies and the way the observations are integrated in hydrological and hydrodynamic models.

In this study, we review the contribution of CryoSat-2 to hydrological applications. CryoSat-2's 369-repeat and the resulting drifting ground track pattern yield a higher overpass frequency over large water bodies compared to short-repeat missions. Moreover, a higher number of smaller water bodies are visited, at least sporadically. The unique sampling pattern has challenged the conventional "virtual station" approach used in river monitoring applications, where time series of WSE observations are extracted at specific locations along a river line. Instead, a longitudinal profile of the WSE in the river is obtained, offering new possibilities for hydraulic characterization of the river. Although the sampling pattern complicates temporal analysis, it has forced the development of new approaches in data analysis and assimilation and studies have shown the benefit of including CryoSat-2 observations, particularly by improving the hydraulic characterization even in highly monitored regions.

For short-repeat missions, simplified rectangular masks or thresholds can be used to extract observations over water bodies. However, to obtain all CryoSat-2 observations, a continuous river mask is required. Such masks can be obtained from optical imagery (e.g. Landsat or Sentinel-2) or from SAR imagery (e.g. Sentinel-1). Particularly the latter offers an interesting synergy with CryoSat-2 observations, as observations are available even for overcast conditions and at relatively high temporal resolution (12 days). Multi-temporal, high-resolution water masks are expected to increase the amount and quality of observations. Furthermore, the combination of dynamic water extent with WSE at high spatial resolution offers new opportunities to assess terrestrial water bodies. In this presentation, we will focus on the various ways, CryoSat-2 has challenged traditional radar altimetry data processing approaches whilst paving the way for SAR altimetry for inland water monitoring and topographical missions such as SWOT.

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